DERMAL ABSORPTION OF TOXICS WHILE SWIMMING

Dermal Absorbed Dose per event for Organic Compounds – Water contact

If $t_{event} \leq t^*$, then $DA = 2FA \times K_p \times \sqrt{\dfrac{6\tau \times t_{event}}{\pi}}$

If $t_{event} > t^*$, then $DA = FA \times K_p \times \left[\dfrac{t_{event}}{1+B} + 2\tau \left(\dfrac{1 + 3B + 3B^2}{(1+B)^2} \right) \right]$

Dermal Absorbed Dose per event for Inorganic Compounds – Water contact

$DA = K_p \times t_{event}$

Where:
DA = absorbed dose per event, in cm/event
FA = fraction absorbed water, chemical specific found in RAGS Part E in Appendix B
K_p = dermal permeability coefficient of compound in water, in cm/hr, chemical specific found in RAGS Part E Appendix B
τ_{event} = lag time per event, in hr/event, chemical specific found in RAGS Part E in Appendix B
t_{event} = Event Duration, set at 1 hr/event
t* = time to reach steady-state, in hr = $2.4\tau_{event}$
B = Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis, chemical specific found in RAGS Part E in Appendix B

DA term is then inserted into Equations 16-19:

1.   For pollutants classified by the U.S.EPA as non-carcinogens, the criteria shall be given by the following equations, except where numeric values are given in Table 1.

(i)   Consumption of water and fish: (Eq. 16)

$$conc\,(\mu g/L) = \dfrac{HBW \times 1000\,\mu g/mg \times RSC}{\dfrac{(FCR \times BCF) + WCR}{RfD_o} + \dfrac{[(DA_{sw} \times EF_{sw}) + (DA_{sh} \times EF_{sh})] \times SA \times CF}{RfD_d}}$$

(ii)   Consumption of fish only: (Eq. 17)

$$conc\,(\mu g/L) = \dfrac{HBW \times 1000\,\mu g/mg \times RSC}{\dfrac{FCR \times BCF}{RfD_o} + \dfrac{DA_{sw} \times EF_{sw} \times SA \times CF}{RfD_d}}$$

Where

HBW = human body weight, set at 70 kg
RSC = relative source contribution, set at 0.2
RfD = reference dose, in mg/(kg-day), chemical specific
FCR = fish consumption rate, set at 0.030 kg/day
BCF = bioconcentration factor, in L/kg, chemical specific
WCR = water consumption rate, set at 2 L/day
DA_{sw} = absorbed dose per swimming event, in cm/event
DA_{sh} = absorbed dose per showering event, in cm/event × (1-SE)
SE = stripping efficiency, chemical specific (SE = 7.95×ln(H')+68.17)
H' = dimensionless Henry's Law Constant, chemical specific
EF_{sw} = swimming event frequency, set at 1 event/day
EF_{sh} = showering event frequency, set at 1 event/day
SA = skin surface area, set at 18000 cm^2, found in RAGS Part E in Exhibit 3-2
CF = conversion factor, set at 1 L/1000 cm^3

2.   For pollutants classified by the U.S.EPA as carcinogens, the criteria shall be given by the following equations, except where numeric values are given in Table 1.

(i)   Consumption of water and fish: (Eq. 18)

$$conc\ (\mu g/L) = \frac{HBW \times RL \times 1000\,\mu g/mg}{(CPF_O \times [(FCR \times BCF) + WCR]) + (CPF_d \times [(DA_{sw} \times EF_{sw}) + (DA_{sh} \times EF_{sh})] \times SA \times CF)}$$

(ii)   Consumption of fish only: (Eq. 19)

$$conc\ (\mu g/L) = \frac{HBW \times RL \times 1000\,\mu g/mg}{(CPF_O \times FCR \times BCF) + (CPF_d \times DA_{sw} \times EF_{sw} \times SA \times CF)}$$

Where:
HBW = human body weight, set at 70 kg
RL = risk level, set at 1.0 x 10^{-5}
CPF = cancer potency factor, in (kg-day)/mg, chemical specific
FCR = fish consumption rate, set at 0.030 kg/day
BCF = bioconcentration factor, in L/kg, chemical specific
WCR = water consumption rate, set at 2 L/day
DA_{sw} = absorbed dose per swimming event, in cm/event
DA_{sh} = absorbed dose per showering event, in cm/event × (1-SE)
SE = stripping efficiency, chemical specific (SE = 7.95×ln(H')+68.17)
H' = dimensionless Henry's Law Constant, chemical specific
EF_{sw} = swimming event frequency, set at 1 event/day
EF_{sh} = showering event frequency, set at 1 event/day
SA = skin surface area, set at 18000 cm^2, found in RAGS Part E in Exhibit 3-2
CF = conversion factor, set at 1 L/1000 cm^3

INHALATION OF TOXICS WHILE SHOWERING

3.   Inhalation Risk is determined by:

$$R = \left[\frac{SE \times F_w \times SD}{V_a + (F_a \times SD)}\right] \times IR \times SD \times EF_{sh}$$

Where:
R = Intake through inhalation (L/d)
SE = stripping efficiency, chemical specific (SE = 7.95×ln(H')+68.17)
H' = dimensionless Henry's Law Constant, chemical specific
F_w= Shower water flow rate, 5.5 L/min
SD = Shower duration, 16 min (95th percentile, Exposure Factors Handbook, 1997)
V_a = Shower stall air volume, 2.3 m^3
F_a = Shower stall ventilation rate, 0.1 m^3/min
IR = inhalation rate, 0.02 m^3/min
EF_{sh} = showering event frequency, set at 1 event/day

An inhalation factor would only be added to equations containing a showering event (Eq. 16 and Eq. 18). These equations would then become:

(i)   Consumption of water and fish for non-carcinogen: (Eq. 20)

$$conc\,(\mu g/L) = \frac{HBW \times 1000\,\mu g/mg \times RSC}{\dfrac{(FCR \times BCF) + WCR}{RfD_o} + \dfrac{[(DA_{sw} \times EF_{sw}) + (DA_{sh} \times EF_{sh})] \times SA \times CF}{RfD_d} + \dfrac{R}{RfD_i}}$$

(ii)   Consumption of water and fish for carcinogens: (Eq. 21)

$$conc\,(\mu g/L) =$$

$$\frac{HBW \times RL \times 1000\,\mu g/mg}{(CPF_o \times [(FCR \times BCF) + WCR]) + (CPF_d \times [(DA_{sw} \times EF_{sw}) + (DA_{sh} \times EF_{sh})] \times SA \times CF) + (CPF_i \times R)}$$